νFDTD: A Novel Algorithm for Improving Conformal FDTD Method

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Dealing with curved or slanted objects has been a challenge in the context of conventional FDTD, since it uses a staircase approximation to model them. To mitigate the effects of this staircase approximation one has to use a very fine mesh, which in turn places a heavy burden on the CPU memory and time. Alternate approach to dealing with such geometries is to use the Conformal FDTD (W. Yu and R. Mittra, Software and User's Guide, Boston: Artech House, 2004.). In this algorithm, the magnetic update equations are modified by using the areas of the partially-filled cells as opposed to their entire cell areas. However this algorithm becomes unstable when the partial area is small, and to circumvent this problem one has to use the entire cell area as opposed to the partially-filled area, and this obviously compromises the accuracy. Recently, a local physical-optics-based reflection coefficient approach was proposed by Panayappan and Mittra (K. Panayappan and R. Mittra, Proc. of IEEE International APS and UNSC/URSI National Radio Science Meeting, 2012), which bypassed the updating of partially-filled cell and was shown to be more accurate than the conformal FDTD. However, this asymptotic approach requires single frequency simulations in FDTD as opposed to those using a Gaussian excitation, which can generate the response over a wide frequency band. In this paper, we modify the above approach by utilizing an interpolation technique which can be used with Gaussian simulations to generate response over a wide frequency range, accurately and efficiently. To illustrate the application of the method we consider a simple geometry, that of a thin PEC plate, whose geometry is shown in Fig. 1a. The plate is located in the middle of a λ/20 cell, and to solve this problem by using the conventional FDTD one must use a cell size of λ/80 or smaller. Although the proposed algorithm still uses a cell size of λ/20, it obtains accurate results, as may be seen from Fig. 1(b), which compares the obtained results with those from the conventional approach. The proposed method has been applied to analyze curved and tilted objects and the results will be included in the presentation.

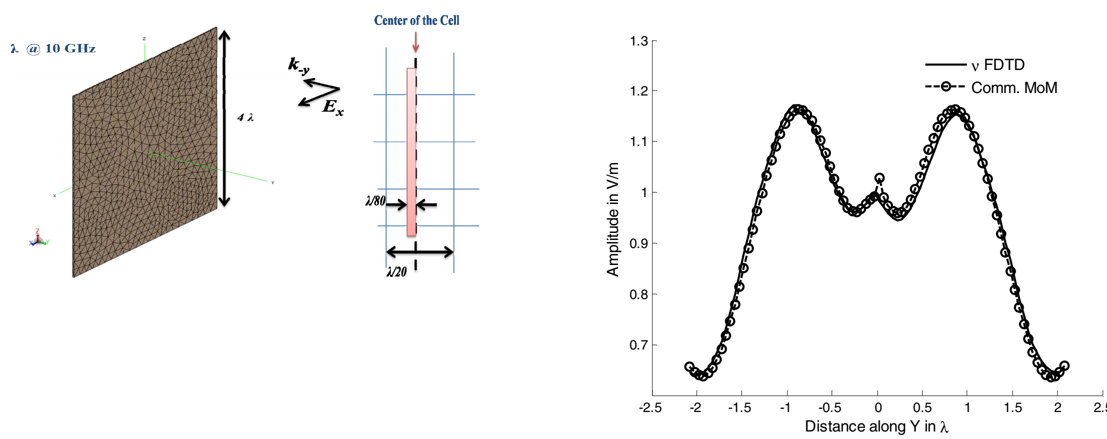

Fig. 1. (a) Geometry of a PEC Plate and (b) Comparison of Scattered E_X Amplitudes.